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APOLLO MONTHLY PROGRESS REPORT (U)

NAS9-150

July 1, 1964

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Report Period

May 16 to June 15, 1964

CLASSIFICATION CHANGE

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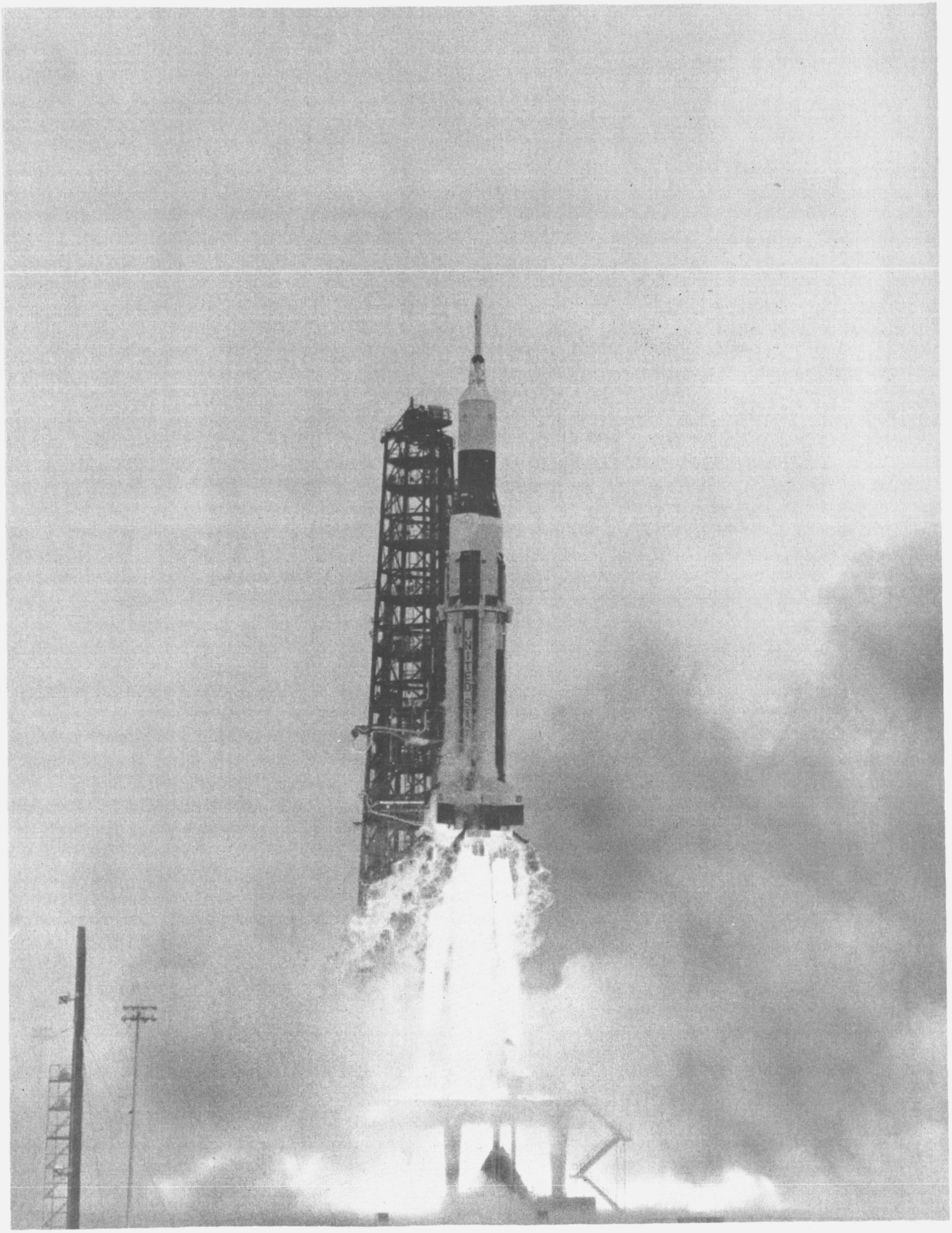

Figure 1. Boilerplate 13 Launch

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PROGRAM MANAGEMENT

STATUS SUMMARY

A major milestone was accomplished during the report period with the successful flight operation of boilerplate 13 from Cape Kennedy. No holds were encountered during the countdown that were attributable to the spacecraft. Countdown was begun at 11:55 p.m. EST on May 27. Launch occurred at 12:08 p.m. May 28 (see Figure 1).

The launch escape tower was jettisoned, and the command module, service module, and S-IV adapter were confirmed in orbit at 12:22 p.m. EST. Telemetry and radar equipment functioned satisfactorily, transmitting data beyond the design life span. The boilerplate vehicle reentered the atmosphere while in the fifty-fourth orbit, 1000 miles south-southwest of Hawaii. Details are contained in the Operations section of this report.

The launch escape tower, command module, service module, and adapter for boilerplate 15 were delivered to Cape Kennedy during the report period. The vehicle will be used to demonstrate the compatibility between the spacecraft and the Saturn launch vehicle under flight loading conditions, to demonstrate an alternate mode of launch escape tower jettison, and for further determination of launch and exit parameters.

Other milestone completions during the report period included the delivery of the launch escape and pitch control motors for boilerplates 16 and 26, the delivery of the earth landing subsystem sequence control for boilerplate 14, the delivery of the fuel cells for boilerplate 14, and the completion of mechanical and physical properties testing on ablative material.

The computer mock-up visual display system for the NAA-Columbus docking study checkout was completed during the report period, and training runs were started. Final preparations were completed for the first series of joint S&ID-NASA zero-gravity flight tests, to be conducted at Wright-Patterson AFB. Tests were conducted on extravehicular transfer, guidance and navigation station mobility, and crew couch restraint.

The first drop tests of boilerplate 2 (water impact test vehicle) were conducted using instrumented anthropomorphic dummies. Motion pictures of the dummies and underwater motion pictures of the boilerplate impact were taken.

Four parachute drop tests were conducted at the El Centro naval air facility during the report period. The bomb-drop tests were conducted using two-chute clusters.

DEVELOPMENT

AERODYNAMICS

Tests of the launch escape vehicle using the jet effects 0.085 scale model were completed in the 16-foot octagonal transonic wind tunnel at Langley Research Center. The tests provided aerodynamic data for the launch escape rocket at simulated low levels of thrust (Mach numbers 0.5 to 1.3) corresponding to thrust at tail-off. Further wind tunnel studies will include the following:

1. Tests at Lewis Research Center to provide dynamic stability data for the canard configuration at Mach numbers 1.5 to 3.5

2. Tests in the Ames unitary plan wind tunnel to provide static force and moment data for the canard configuration through 360 degrees angle of attack

3. Tests at Arnold Engineering Development Center to determine the effects of holes and protuberances on heat transfer distributions over the surface of the command module

MISSION DESIGN

Definition of the mission for spacecraft 009 was resolved at a meeting between S&ID and NASA-MSC on May 26. Mass characteristics and all significant mission details were established for the launch vehicle and the spacecraft.

The spacecraft 009 mission profile (shown in Figure 2) is defined as follows:

1. Boost profile at near-nominal for S-IB booster stage

2. Boost profile of modified S-IVB stage optimized for propellant loadings, with consideration given to launch weight

3. S-IVB-spacecraft separation at approximately 30 seconds after S-IVB shutdown to allow damping of shutdown transients

4. Two SPS firings: one long-duration firing of approximately 235 seconds, a 15-second coast, then a 10-second firing

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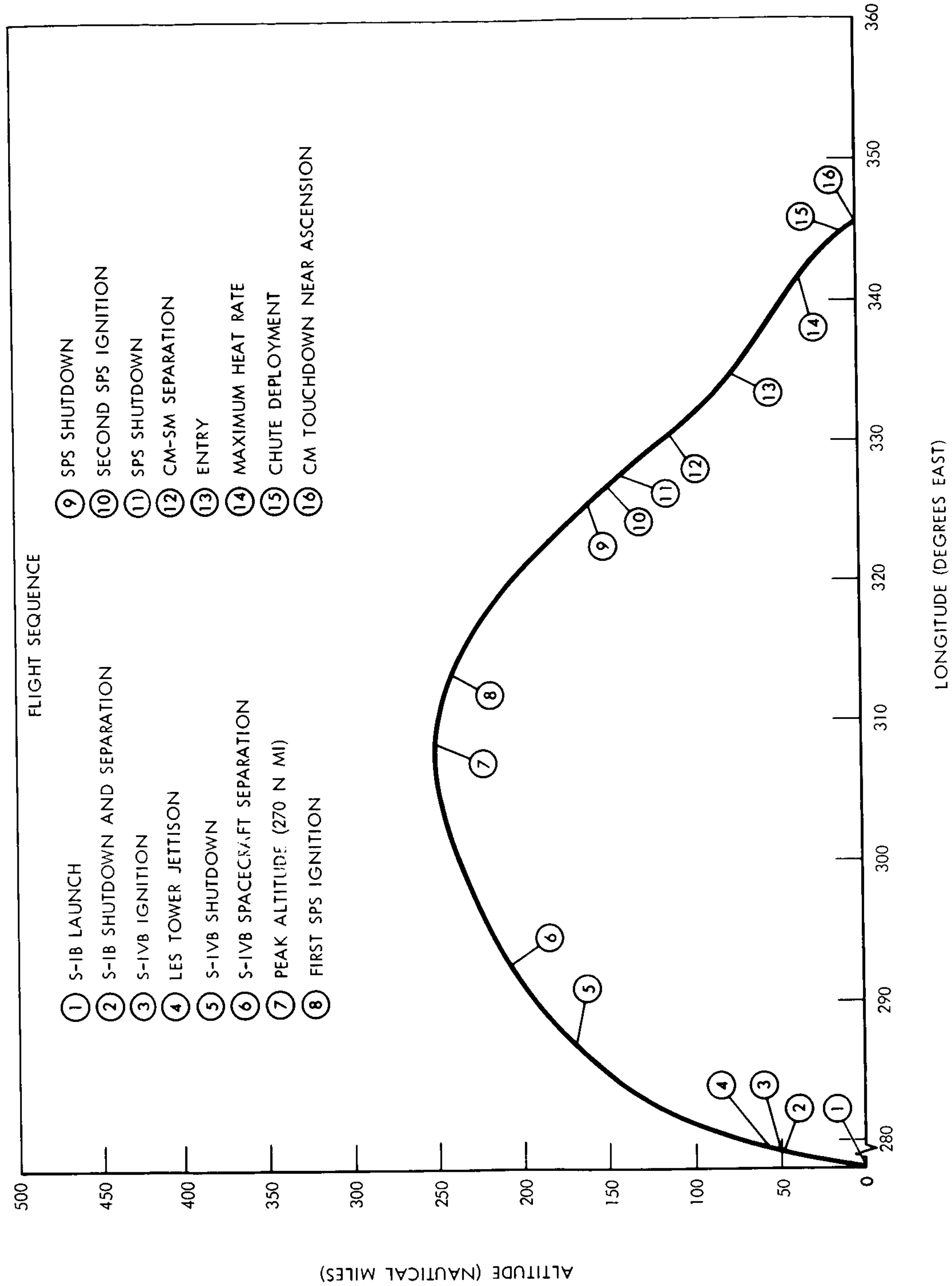

Figure 2. Spacecraft 009 Mission Schematic

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5. Minimum time between SPS shutdown and 400,000 feet altitude: 120 seconds

6. Full lifting entry and zero-degree roll angle

7. Flight entry path angle relative to the local horizontal: approximately -9.3 degrees; and velocity: approximately 28,500 fps

Both missions A501 and A502 are director and response tester (DART) missions in which the spacecraft will be boosted by a Saturn V into a highly elliptical earth orbit. Mission A501 will have a short entry range to produce maximum heating rates; A502 will have a long entry range to impose maximum heating load. Mission trajectory profiles were generated for both A501 and A502 based on the following ground rules:

1. Extended cold soak, i.e., the spacecraft will spend between 50 and 75 hours above 20,000 nautical miles altitude.

2. Both translunar injection from earth parking orbit and lunar orbital insertion by SPS burn will be simulated.

3. Mission duration will be approximately three days.

4. Command module recovery is of prime importance in both missions.

A qualitative description of these trajectory profiles is as follows. Launch azimuth will be 108 degrees, with nominal Saturn V boost into a 100-nautical-mile parking orbit for three revolutions. Injection from earth orbit will occur with a zero-degree flight path angle into an 84,290-nautical-mile apogee altitude trajectory for translunar injection simulation. At apogee, a 15.6-fps retro ΔV impulse will be applied to place the spacecraft on a nominal entry trajectory.

Approximately six hours after apogee, a rotation maneuver will be performed with the SPS to obtain a long-duration burn. The rotation maneuver will be performed by continuously applying the SPS thrust vector at right angles to both the instantaneous velocity and radius vectors. This thrust program will result in a rotation of the nominal trajectory conic about the radius vector without changing the shape of the conic. The trajectory conic will be rotated 360 degrees; at the termination of the burn it will be back in the original trajectory plane on the same nominal entry trajectory. Further, if the SPS burn is terminated prematurely (before a 360-degree rotation is achieved), the spacecraft will still be on a nominal entry trajectory and will land at the nominal water landing site near Haiti. The landing approach azimuth, however, will be a function of the angular rotation achieved.

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About five minutes prior to nominal entry, a short SPS burn will place the spacecraft on a high heat rate entry for mission A501 or a high heat load entry for mission A502. In mission A501 the spacecraft will touch down near the Bahama Islands; in mission A502 touchdown will occur either near Brazil or near Ascension Island depending on the heat load entry profile used. Total flight time for either mission will be 72.4 hours.

Table 1 furnishes mission performance data and Table 2 provides mission entry characteristics.

Table 1. Mission Performance Data

Item	A501 & A502
S-IVB injection burn duration (second firing)	314.1 sec
Apogee altitude	84,290 n mi
Command and service module weight prior to first firing	58,000 lb
SPS retro burn duration at apogee	1.3 sec
SPS rotation burn duration (6.7 hours after apogee)	493.5 sec
Time from injection to entry	67.9 hr

Table 2. Mission Entry Characteristics

Item	A501 High Heat Rate	A502 High Heat Load
SPS burn duration prior to entry	27.6 sec	17.7 sec
Entry velocity	36,200 ft/sec	36,200 ft/sec
Entry flight path angle	-8.94 deg	-5.45 deg

CREW SYSTEMS

NAA-Columbus completed 84 combined training and data runs for the transposition phase of the docking simulation study. Parameters simulating the free-flight docking method under different lighting conditions, using various sighting devices and with different targets mounted on the lunar excursion module, were measured. Upon completion of the training runs, three test subjects began a series of data runs.

S&ID participated in a series of tests at MSC, using Apollo Phase B and Gemini pressure garments in a mock-up of the command module.

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Visual and reach envelopes at the main duty stations were studied. The use of the Gemini space suit, either ventilated or pressurized, facilitated reach of the controls on the structural frame at station 42.665.

As a result of the requests for changes made at the design engineering inspection (DEI) of the spacecraft 011 mock-up on April 28 and 29, a study is under way to change the restraint harness assembly. Still and motion pictures of restraint tests performed by NASA at the Holloman Air Force Base, using the Daisy Track and human subjects, were analyzed. Studies show that the restraint harness should consist of a chest strap, a shoulder harness, and a lap belt, with the latter two connecting into a one-point release at the lap. Hardware for this type of harness is being procured for review at the DEI scheduled for July.

Three NASA-S&ID zero-gravity flight tests were completed at Wright-Patterson Air Force Base as follows.

First, an extravehicular transfer test was conducted to verify the capability of crewmen, under weightless conditions, to pass through the proposed 32-degree main access hatch of the Block II command module. Test subjects, wearing pressurized suits, were able to pass through in either direction.

Second, a crew couch restraint test was run, using the boilerplate 14 configuration, to evaluate crewman capability to attach the crew couch restraint system under weightless conditions. Test subjects were able to place themselves into the left couch but were unable to attach the couch restraint system.

Third, a test was made of the restraint subsystem at the guidance and navigation station. This was a preliminary S&ID-MIT interface test to evaluate the restraint subsystem under weightless conditions with respect to size and attachment configuration. All restraint system devices for the lower equipment bay (consisting of boots, sandals, telescopic bars, and take-up reels) functioned adequately.

STRUCTURAL DYNAMICS

As one of a series of command module flotation investigations, preliminary analysis indicates that a single upright stable position can be achieved by the buoyancy change of an air-inflated bag 34 inches in diameter attached to the command module exterior. This calculation was based on the assumption that certain skirt areas of the command module will be flooded. If flooding does not occur, the required air volume of the bag will be doubled. Investigations are under way to provide a positive means of achieving the desired flooding and water retention.

A series of water drop tests, using a tenth-scale model of the command module, was completed on June 4. The tests were to investigate impact accelerations and stability for landing at pitch attitudes greater than 35 degrees. Preliminary data indicate that translational accelerations are reduced from those found in previous tests at lower pitch angles.

The flights of boilerplates 12 and 13 furnished data on aerodynamic pressure, vibration, and vehicle acceleration. Flight test data for boilerplate 12 confirmed the predictions obtained from wind tunnel tests for general spectrum shapes and for a maximum noise level of 167 decibels for the over-all boundary layer. Preliminary analyses of boilerplate 13 flight data showed random vibration responses, as measured by service module pickups, with no excitation by aerodynamic noise or other acoustic sources of the shell-type or bending modes of the basic vehicle. The detailed analyses of the narrowband spectrum, now in progress, are expected to confirm these early analyses.

STRUCTURES

Post-flight analysis of boilerplate 12 revealed structural failures of the 10-inch extension of the service module, the shock-wave barrier, and the service module camera mount. These failures were attributed to the heavier-than-anticipated explosive forces that occurred when the thrust of Little Joe II was terminated by detonation. The following corrective measures are being taken to prevent a similar occurrence on boilerplate 23: The thrust of Little Joe II will be permitted to terminate by burning out. The explosive charge, although still needed for range safety, will be reduced. The thickness of the shock-wave barrier will be doubled.

Examination of glass specimens mounted in the launch escape subsystem (LES) plume areas on the boilerplate 12 command module revealed that sooting had reduced light transmissibility by 35 to 65 percent. Studies of these specimens are in progress to obtain other data.

Meteoroid shielding experiments were performed by the Defense Research Laboratory of the General Motors Corporation to determine the effectiveness of multisheet meteoroid protection. A summary of the results of these shielding studies, together with S&ID recommendations, was sent to NASA-MSC. A preliminary study reveals other failure modes not present in single-sheet shielding.

The dynamic analysis for an LES with flexible canards was completed to determine the dynamic response of the ends of the canards to the actuating force applied at the center of the panel. Results indicate an increase in rigid body loads of less than 5 percent. This analysis was confined to acceleration-time histories during panel deployment. Conditions included worst airloads tending to open the canards, detonation of both pyrotechnic charges, maximum pyrotechnic peak force, and minimum viscous damping coefficient. This combination of conditions, in conjunction with the kinematics of the deployment actuating system, produces a sharp deceleration for the canard panel that reaches a peak at a deployment angle of 109 degrees (6 degrees short of the full open position).

Design of the boost protective cover was 100 percent released for boilerplates 22 and 23. This cover completely encloses the conical portion of the command module. Thus, the windows and the thermal coating (to be applied to the surface of the ablative material on the conical section of later spacecraft) will be protected from the exhaust plumes of the LES motor. The cover is of hard construction from the apex down to the parachute deck and pliable below the deck. The cover will be attached directly to the LES tower and will be jettisoned with it.

FLIGHT CONTROL SUBSYSTEM

Stabilization and Control Subsystem (SCS)

The SCS model specification was completed and is being released. A design review of the thrust vector control (TVC) was held at Honeywell on June 1. The feasibility of incorporating proposed changes to compensate for body bending and actuator effects, and to increase the TVC servo amplifier output from 300 ma to 600 ma, is being investigated.

Preparation for additional astronaut training with manual TVC simulation is under way. The simulation is planned for late June at Honeywell and will include a star field display.

Electronic Interfaces

Design verification testing of the subminiature connectors was completed by Hughes Electronics; however, supplementary tests will be required to ensure an accurate evaluation. The 22-gauge annealed contacts for use with these connectors (designed to eliminate the fracturing problem) are now available.

NASA, Grumman, and S&ID are conducting a series of meetings to standardize the displays and controls for the lunar excursion module and the command and service modules. Specific points of standardization have been agreed upon, and specific action items have been assigned. The next meeting is scheduled for mid-June.

Flight Subsystem Analysis

A docking simulation study was started at NAA-Columbus in late May. The principal objective of the study is to verify the need for a sighting device in the command module (with service module attached) to ensure that the SCS provides sufficient docking capability and to determine the reaction control subsystem (RCS) duty cycle during docking. The study employs the latest models of the hand controllers, flight director attitude indicator, and window-couch geometry. The quality of the visual image presented to the astronaut subjects is improved by the use of an Eidophor TV projector. Helmets and gloves will not be used during the remainder of the study; analyses indicate that their use, or lack of use, has no effect on test results.

Automated Control

Mechanical Boy studies were completed and transmitted to NASA-MSC. The purpose of the studies was to determine the effect of various attitude inaccuracies at the time of ΔV firing on the capability to perform the NASA-recommended trajectory for spacecraft 009. Analyses were included of the minimum time required to perform each of the various functions during normal mission operations and in the event of a single RCS failure.

Director and response tester (DART) functional subsystem timelines were developed and transmitted to MIT as background data for the identification of specific electrical interface loads and operational constraints.

TELECOMMUNICATIONS

Communications

Design reviews were held at Collins Radio to freeze the development model design on the VHF/AM transmitter-receiver, the VHF/FM transmitter, and the HF transceiver. The design verification tests of the engineering models of this equipment were satisfactory.

A computer program was developed for calculating the radiation pattern of an array of antennas on a cylinder. This program provides a simplified method of evaluating antenna arrays for the spacecraft. It is presently being used to establish VHF/UHF antenna parameters for the service module, the command module, and the service module destruct equipment.

Instrumentation

A detailed study resulted in the elimination of approximately 840 measurements for spacecraft 008. A revised measurement requirements list was published reflecting these deletions. A complete list of operational and flight qualification measurement requirements for spacecraft 012 was published.

Procurement of the critical heat shield instrumentation, except for heat flux sensors, was initiated for spacecraft 009 and 011. The heat flux sensor data are needed primarily for analytical purposes and thus do not warrant delaying flight schedules.

ENVIRONMENT CONTROL

A computer study was completed of the cabin temperatures during a simulated entry with the maximum allowable temperature (600 F) at the aft heat shield ablator bondline. At touchdown the temperature of the cabin floor was 194 F, the cabin side walls 138 F, and the cabin air 107 F.

Preliminary results of a study to determine if moisture will form on command module equipment during prelaunch activities indicate that the cabin air dew point will range between 45 F and 41 F with a corresponding range of 43 to 37 grains of water per pound of dry air. These dew points are based on an air recirculation rate of 40 pounds per minute.

A test was made to determine the accessibility to the astronauts of the environmental control subsystem (ECS) valves in the command module cabin. All valves could be reached by the astronaut subjects wearing unpressurized suits. Wearing pressurized garments, the astronauts were able to reach the oxygen metering valve but not the manual controls for the cabin pressure relief valves. Corrective action is under way.

Potential corrosion problems in the water-glycol loop were studied at AiResearch. In 60 days of operation, a circulating system using Apollo components did not show any indication of corrosive wear or buildup. Thus, no additional corrosion tests of Apollo components will be required. Experience has shown that adding a rust inhibitor to the water-glycol solution and keeping the system filled, rather than draining and flushing after usage, maintains the system free of corrosion.

The test program for the manned ECS breadboard was completed. Initial checkout and testing is scheduled to begin December 1, 1964; all testing is to be completed by April 1, 1965. Figure 3 shows the 15-ton metal vacuum cell suspended over the ECS breadboard which will be used for the manned tests. 75 percent of the secondary structure is fabricated, with approximately 30 percent installed in the test article.

A thermal analysis indicates that 0.2 inches of corkboard ablator will be required on all external surfaces of boilerplate 22 in addition to the boost protective cover to prevent the substructure from exceeding the maximum temperature limit of 250 F during entry from an abort at approximately 120,000 feet. All penetrations of the aft heat shield will be sealed or

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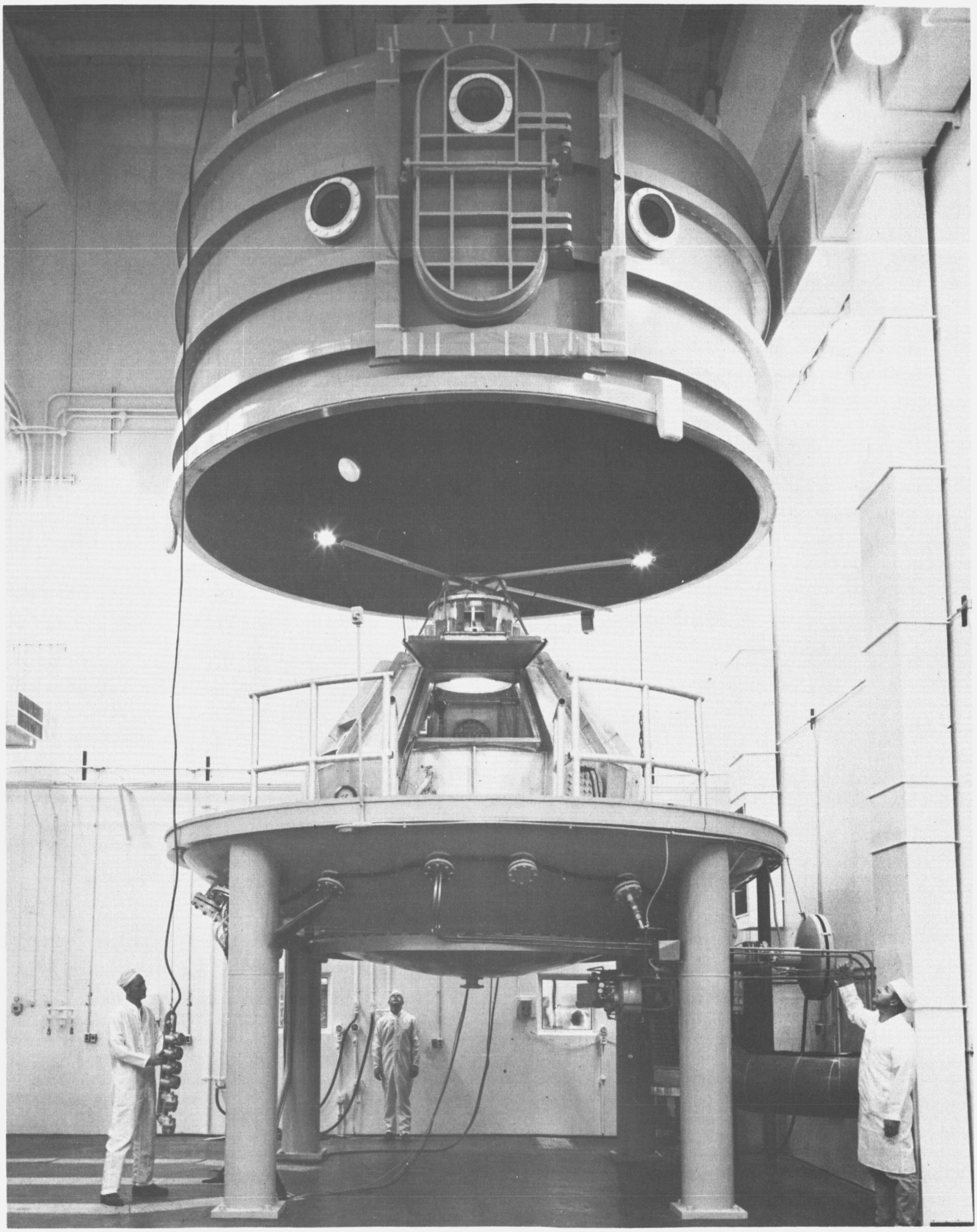

Figure 3. 15-Ton Metal Vacuum Cell Suspended Over ECS Breadboard

deadened as additional protection. These precautions will not be necessary, however, on boilerplate 23 because of its 36,000-foot abort altitude.

Thermal analysis, assuming a cold soak after completion of the boost phase for spacecraft missions, indicates that the temperature of the tie-down strap for the lunar excursion module will reach a maximum of 160 F during boost and a minimum of 10 F at the time of LEM separation. Anticipated maximum temperatures of the drogue and pilot chute mortars, prior to drogue chute deployment, are 167 F and 182 F, respectively. Maximum allowable temperature for both straps and mortars is 250 F.

ELECTRICAL POWER SUBSYSTEM (EPS)

The first prototype inverter, scheduled for delivery by Westinghouse in June, developed excessive acoustical noise and unsatisfactory EMI characteristics. Solutions to these problems are being investigated.

Qualification testing of the titanium pressure vessels is 95 percent complete. Three of the four test vessels were successfully subjected to burst test. Two of these vessels were burst at liquid hydrogen temperature and the third at room temperature. The fourth vessel successfully completed the 14-day creep test.

The Inconel 718 qualification test program was started. The first test vessel will be subject to burst test in mid-June, using liquid nitrogen as the test fluid.

The two oxygen tanks for spacecraft 006 completed end-item acceptance tests, including vibration proof tests at design levels while fully loaded with inert fluid. The tanks are scheduled for delivery to S&ID in late June.

The vacuum chamber installation for the combined testing of three fuel cells was completed; test equipment is being fitted to the chamber. Fuel cell testing is scheduled to start by mid-July.

The model of the fuel cell for computer studies of heat transfer was revised to include the added temperature control subsystem shelf in Bay IV of the service module. This model was used to determine the fuel cell heat loss to the service module for five different cases involving environmental and power demand conditions. The fuel cell heat losses with the shelf are approximately 20 percent lower than those previously calculated without the shelf. While the shelf helps to decrease over-all fuel cell heat loss, higher temperature results in the fuel cell accessory package. The possibility of accessory package overheating is being investigated.

Humidity testing by Cannon Electric of both the forward compartment and the launch escape subsystem (LES) umbilicals disclosed failures of insulation resistance and lack of contact continuity. Investigation showed that the insulation failure was the result of incorrect hole sizes in the grommet seals. Improper tool setting caused the continuity interruption. Corrective action was taken in both cases.

In earlier qualification testing of the bulkhead electrical feedthroughs, the type 303 stainless steel test samples failed the contact resistance tests. Cannon Electric is changing to a nickel alloy steel pin. Qualification testing should be completed by early August.

A successful test was performed to verify the feasibility of bonding wires to an epoxy-base polyamide embedment material in the command-to-service-module umbilical.

PROPULSION SUBSYSTEM

Service Propulsion Subsystem (SPS)

The 1-inch diameter elbow that enters the SPS propellant tank door is being repositioned, and the connecting 1-inch helium pressurization line is being rerouted to eliminate unnecessary bends, in compliance with the request for change made by the spacecraft 011 mock-up design engineering inspection review board.

The first fireable service propulsion engine was delivered to WSMR on May 11 for testing on the F-2 fixture.

Water flow and engineering acceptance tests of the F-3 test fixture were completed at S&ID. The fixture is being prepared for shipment to AEDC to support the SPS engine altitude test program.

The dynamic stability program continued with 41 firings during this report period. The five-baffle injector configuration has demonstrated dynamic stability and ablative chamber compatibility with characteristic velocity (C*) of about 96.5 percent during limited testing to date.

Table 3 lists all firings conducted during this report period.

Reaction Control Subsystem (RCS)

Design verification testing (DVT) of both the propellant disconnect coupling and the helium fill disconnect was successfully completed, and DVT of the helium pressure isolation valves was begun.

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Table 3. Apollo SPS Engine Test Program

Serial No.	Pattern Type	Type of Evaluation	Ablative Chamber		Steel Chamber		Engine		Remarks
			No. of Firings	Time (sec)	No. of Firings	Time (sec)	No. of Firings	Time (sec)	
AFF-27	POUL-31-47	600 cps investigation	4	44					Helmholtz resonator installed—slightly reduced 600 cps oscillations
AFF-32	POUL-31-43	600 cps investigation	23	279	10	56.0			Ten firings with monomethylhydrazine
AFF-34	PONX-51-11	Performance evaluation			2	1.49			Two CSM shutdowns—testing discontinued
AFF-78	POUL-31-10	Injector acceptance	1	30	5				Face ring braze joint leak discovered
0007	Engine assembly (AFF-54)	Balance					1	12	Gimbal actuators installed
5-4-4 0009	POUL-41-22	Checkout			3	14.0			Satisfactory
		Pulse			2	10.8			156.9 grain pulse—satisfactory recovery
		C*			5	28.0			C* = 96.5%
		Injector/chamber compatibility	20	932					Satisfactory—two baffle cracks noted
5-4-4 0006	POUL-41-22	Balance			1	3.5			Satisfactory
		Pulse			2	10.0			156.7 grain pulse
		Performance evaluation			1	5.81			Satisfactory
		C*			5	30.0			C* = 96.5%
6-4-2 0007	POUL-41-22	Checkout			2	2.65			Two CSM shutdowns

*Characteristic exhaust velocity

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Leak tests and functional checkouts were completed for potential qualification test components of the command module RCS using breadboard panels. The checkout included proof pressure, internal leakage, and functional check of the components. The panels are now mounted on the breadboard fixture, and distribution lines are being connected to the panels in preparation for complete command module RCS equipment development tests.

Marquardt began testing on the first two-piece thrust chamber of the service module RCS engine. The two-piece construction permits the use of any of several ductile refractory materials for the combustion chamber; it is expected to minimize any weight increase that may be required if the chamber strength must be increased to contain ignition spikes.

Launch Escape Subsystem Motors

During the boilerplate 12 flight the LES rocket motors appeared to function normally. However, the motor chamber pressure signal was lost, and no measured data were obtained. The total impulse of the pitch control motor, calculated from pressure data, appears to have been 5 percent below the predicted value. Cause of this deviation is being investigated.

The tower jettison motor for the boilerplate 13 flight appears to have operated satisfactorily. The launch escape and pitch control motors were inert.

The tower jettison, pitch control, and launch escape motors for boilerplate 15 and its spare were shipped to AMR. The empty boilerplate 16 LES was shipped from Lockheed to S&ID, Downey.

Meetings were held with Lockheed and Thiokol to effect a cost reduction. As a result, the two temperature gradient motors in each of the qualification programs were eliminated.

Eight launch escape motors and ten pitch control motors were cast during this report period.

Propulsion Analysis

Tests were conducted to determine the effect of weightlessness on hypergolic fluids in the service module propellant tanks during normal spacecraft coast and maneuvers. To simulate these conditions, zero g was achieved in the tests by dropping a small clear Plexiglas model of an SPS propellant tank a distance of 72 feet during which time a speed of 60 fps was reached to produce a weightless condition for 1.2 seconds. The Plexiglas tank (half filled with a colored fluid) and a high-speed (400 frames per second) motion picture camera with a light source were enclosed in a shock resistant shield for the drop. The resulting film was excellent and shows the rotating tank and colored water very clearly; studies of the film strip are in progress.

Preliminary testing was completed in the USAF zero-g flying laboratory (a KC-135 aircraft). An eighth-scale Plexiglas model of an SPS tank with a retention reservoir and screens was observed and photographed during thirty zero-g parabolas of 20 seconds each. The photographic data will be analyzed and used to determine the testing techniques and equipment for the formal zero-g or low-g tests scheduled to begin in July 1964 using this aircraft.

The effects of the interactions of the command module RCS jets on control response and propellant consumption were evaluated for the dual stabilization and control subsystem (SCS) mode. An analysis was made of the interference effects of two engines firing simultaneously in close proximity. An interaction force 2.2 times greater than that of a single firing system is predicted for the firing of the dual system of yaw motors. The pitch and roll engine interactions are not affected.

DOCKING AND EARTH LANDING

Four main parachute drop tests were conducted at El Centro during this report period in a continuing effort to optimize opening characteristics and minimize loads.

Reaction loads in the pilot and drogue mortars were reduced to a level below specification requirements. This reduction was achieved by the use of smaller restrictor orifices between the breech and plenum chambers and by removing the seals from the sabot to reduce friction.

Plans are being made for the boilerplate 23 earth landing subsystem to employ the boilerplate 12 configuration for main and pilot chutes, a modified sequencer, and a reefed drogue subsystem. Delivery of the sequencer is expected in early July, delivery of the chutes in early August.

Drop test facility changes are in process as a result of the decisions to adopt water impact as the primary landing mode. The extension of the drop test pool was determined, the pendulum platform drawings were completed, and additional slings were fabricated.

Revisions of the crew couch attenuation design to incorporate the latest crew acceleration limits and to incorporate the lockout mechanism were completed.

The design of the docking probe mechanism to be used in the command-service-module-to-lunar-excursion-module docking has been established. The tri-attenuator mechanism was selected on the basis of flexibility of design for possible load and stroke growth, simplicity, redundancy of attenuation, and weight savings. Drawing release for the test hardware is scheduled for mid-July.

GROUND SUPPORT EQUIPMENT (GSE)

Acceptance Checkout Equipment (ACE-SC)

An improved Block II configuration for ACE carry-on hardware was developed. The present configuration requires the removal of fly-away equipment in order to attach the carry-on hardware to existing hardpoints on the command module floor. The new concept is designed to be supported by the crew couches and does not require this removal. The resultant installation and removal time saved is estimated to be 60 percent. The response portion of the Block II configuration is in two parts: the first part is used during integrated systems testing, and the second part augments the first part for individual and combined systems tests. This configuration minimizes the amount of test hardware required during launch pad operation.

Special Test Units (STU)

Requirements for the conditioning of signals used only by STU were identified, and the requirements for all other measurement channels monitored by STU were verified. Over 2000 test points were reviewed. The results of this effort were used to freeze the design requirements for several external conditioner models. Individual STU system block diagrams for all test locations (Downey, WSMR, and Cape Kennedy) were completed. The block diagrams identify all pertinent interfaces and indicate signal measurement flow.

Auxiliary and Substitute Units

Modification of boilerplate 12 GSE for use on boilerplate 23 was begun. The following GSE models are affected:

- Test conductor's console
- C-band radar transponder
- Signal conditioner console
- Pyrotechnic initiator substitute unit
- Launch vehicle substitute unit (Little Joe II)

Modifications of the boilerplate 13 launch control group and the launch vehicle substitute unit for use in boilerplate 15 were completed. The equipment is now being checked at Cape Kennedy.

The following GSE models were affected.

GSE Cable Subsystem

A complete rescheduling of cable subsystem design is being made to reflect improvements in design standardization, procurement, and manufacturing. This improvement is required mainly for cable sets to be used at Houston and special test areas at Cape Kennedy.

Spacecraft Instrumentation Test Equipment (SITE)

Systems integration tests on the first deliverable SITE unit began in May at Autonetics. This phase of testing accomplishes the mating of all elements of the unit, including the tape reader, the manual input, the command logic, the stimuli generation equipment, and the measuring equipment. In support of these tests, Autonetics received the single-channel decommutator from Radiation Laboratories during this report period. Typical items of SITE bench maintenance equipment are shown in Figure 4.

AiResearch has established the concept, block diagrams, and proposed methods of mechanization for all of their basic models.

Servicing and Checkout GSE

Predelivery acceptance testing of the fuel and oxidizer ready storage units was started April 14 and completed May 28. Both units were delivered to the PSDF at WSMR on June 3. Figure 5 shows the skid-mounted fuel ready storage unit. The capacity of each tank is approximately 3500 gallons, enough to fill the Apollo spacecraft at the launch site and retain 250 gallons in reserve.

Handling GSE

The LES weight and balance fixture was redesigned to eliminate the improper use of load cells as leveling jacks, which had caused side loads to be introduced in the readout. Adjustment devices were added to the forward and aft reaction points of the fixture for leveling purposes. Weight and balance measurements at both Downey and Cape Kennedy indicate that the redesign is satisfactory. Figure 6 shows the means for adjusting the leveling device at the forward reaction point.

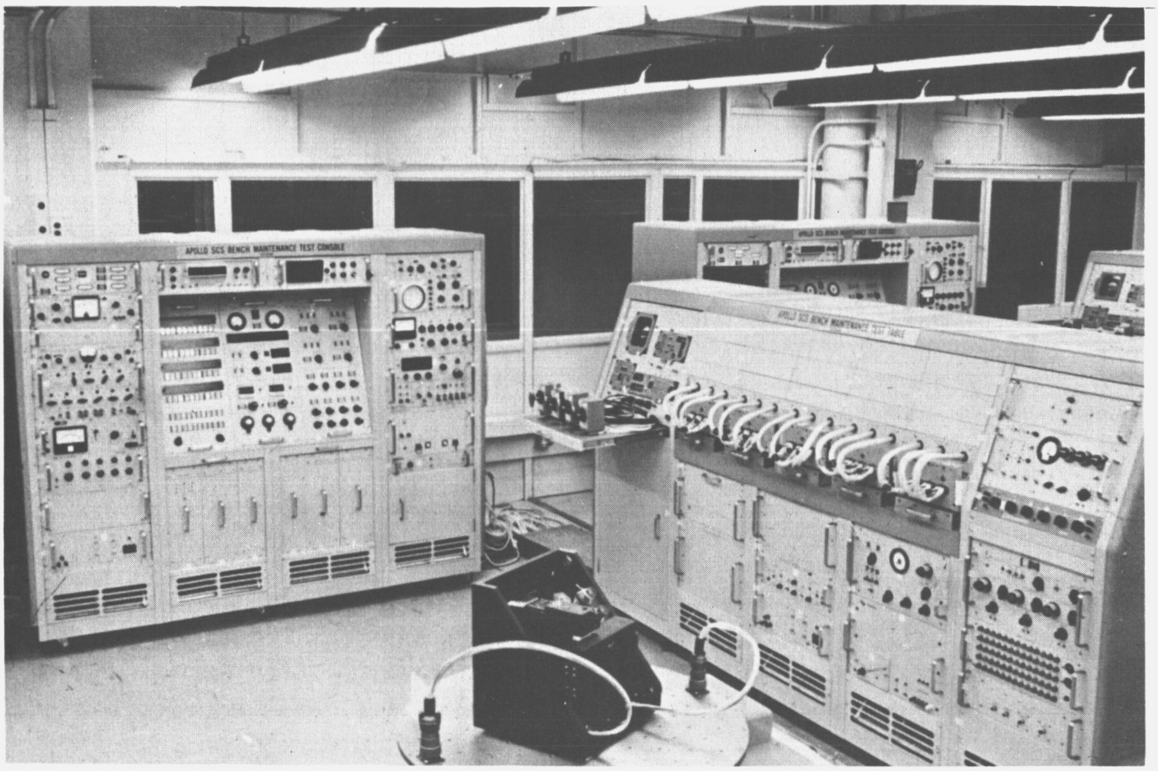

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Figure 4. SITE Bench Maintenance Equipment

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Figure 5. Fuel Ready Storage Unit

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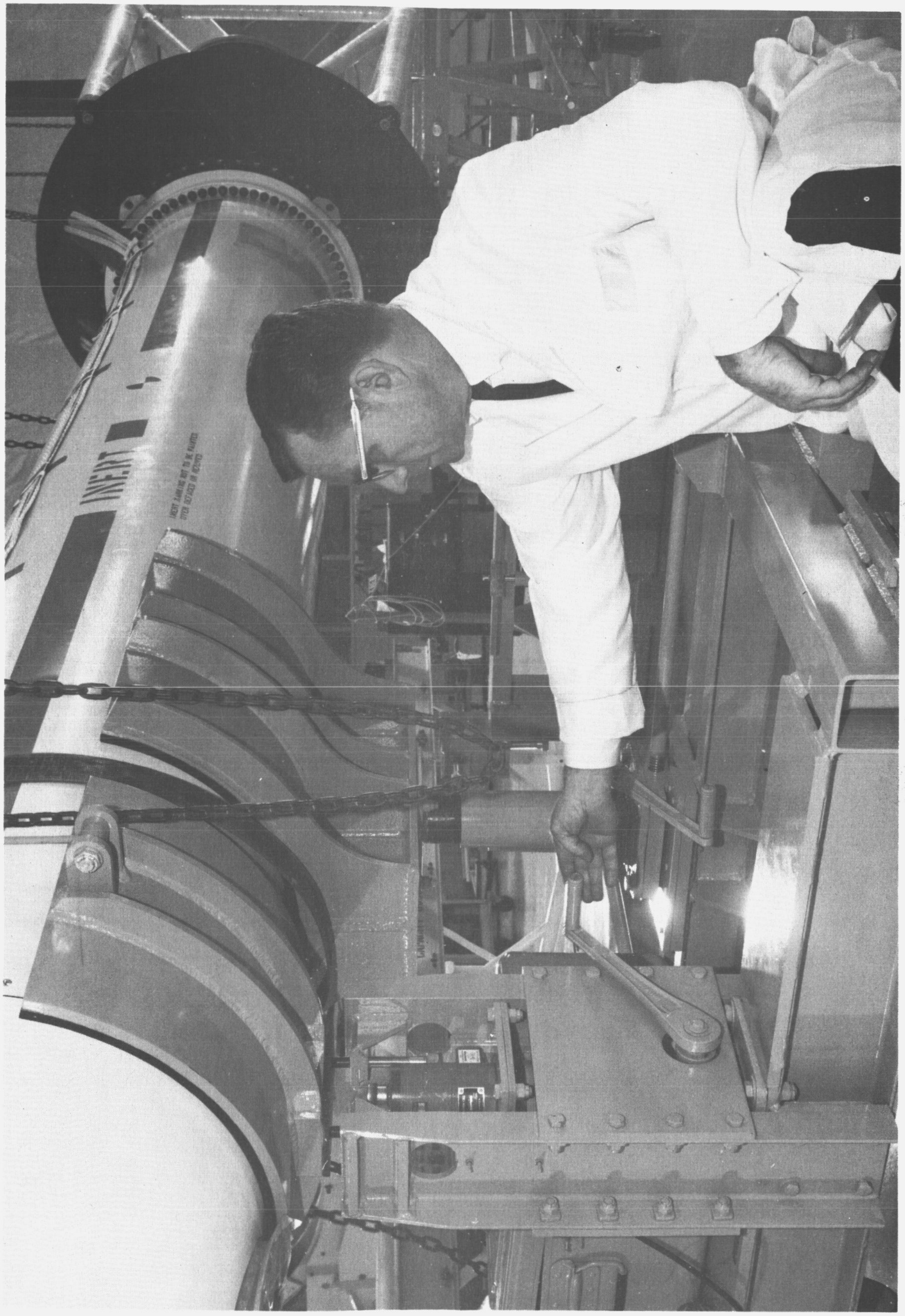

Figure 6. Forward Load Cell Reaction Point and Jack Housing

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SIMULATION AND TRAINERS

The flight table used to simulate the dynamic motion of the spacecraft in the simulator complex was modified at Shawnee Industries prior to initiation of acceptance tests. The feedback control potentiometers were lacking rigidity and induced a slight continuous oscillation about the command positions. The redesigned potentiometers were installed on the flight table on June 14.

Engineering runs, to be witnessed by S&ID personnel, are scheduled to begin approximately the third week of June to determine that the flight table is ready for acceptance testing, with delivery to S&ID anticipated in early July.

VEHICLE TESTING

A program plan document for boilerplate 14 to define test program ground rules, subsystem installation, subsystem checkout and operation, integrated checkout of all subsystems, and GSE usage was released. The plan will be updated as necessary to reflect the latest program changes. All engineering releases are completed for the initial configuration of boilerplate 14. Plumbing and wiring are being fabricated and installed, with start of system testing scheduled for late July.

The combined subsystems checkout of boilerplate 15 was completed, modifications were incorporated, and the demated vehicle was shipped to Kennedy Space Center. These modifications included the replacement of dual mode bolts by single mode bolts, the relocation of radial accelerometers, and required changes in all portions of the RCS engines and instrumentation except for one RCS engine kit which will be installed at Cape Kennedy.

Boilerplate 23 modifications will support the start of checkout operations in early July. These modifications include dual drogue parachutes, and the addition of canards, a boost protective cover, and associated changes in sequencers, wiring, and GSE. The release of all engineering drawings is nearly completed.

As a result of data gained from the boilerplate 12 flight test, a strengthened blast barrier is being installed in the service module of boilerplate 23 in order to contain the concussion from the explosive thrust termination of Little Joe II.

The cryogenic subsystem, EPS, and ECS plumbing mock-ups were completed for spacecraft 001. SPS plumbing mock-up below the aft bulkhead was completed. Approximately 30 percent of the fluid lines are installed in the vehicle, and brazing operations were begun. The primary wire harnesses for the service module are in the final stages of assembly, with installation scheduled to begin in late June. All RCS panel wiring harnesses are in the mock-up stage.

The cryogenic tank delivery schedule for spacecraft 001 does not support the present vehicle schedule; tank installation at PSDF is planned. Vehicle test operations will not be affected because the cryogenic tanks, if installed, would have been removed prior to initial SPS testing.

The spacecraft 006 forward and aft portions of the crew compartment pressure vessel were joined by welding, marking a significant first accomplishment. Analysis of the post-welding X ray revealed minor cracks which were repaired by the application of bonding doublers. Drilling of the command module for heat shield and substructure tie-points is in process. The next major operation on this pressure vessel will be a pressure proof test.

RELIABILITY

Reliability studies for Block II weight reductions were completed. The objective of these studies was to select configurations that give maximum weight reduction and reliability improvements, with mission success and crew safety as prime considerations.

All Block II configurations show greater reliability for a 10-day mission than Block I for a 14-day mission. The Block II configurations which were studied consisted of four basic types:

1. A minumum modification to the present spacecraft to accommodate operations with the lunar excursion module

2. The minimum modification plus changes that would yield the greatest weight reduction per dollar

3. A configuration that included the two configurations noted above plus weight reduction changes of lower pound-per-dollar yield

4. A configuration that included all changes noted above plus further weight savings through the incorporation of new structure and subsystem design concepts

This last configuration results in the highest mission success and crew safety reliability.

The effect on crew safety of alternate engine systems proposed as backup for the large SPS engine was studied. These alternate systems included various combinations of the lunar excursion module ascent and descent engines, and the SPS vernier engines augmented by the SPS fuel dump and SPS parallel feed. The most significant reliability increase was shown by the use of the vernier engines with SPS fuel dump.

A reliability trade-off study indicated that the power supply and voice discriminator modules of the premodulation processor should be made redundant in the Block II configuration in lieu of a redundant S-band power amplifier. This trade-off will result in a 1.5 increase in reliability per pound of added weight, whereas a redundant S-band power amplifier, used in a secondary operational mode, would have only a negligible effect on reliability. The premodulation processor is shown in Figure 7.

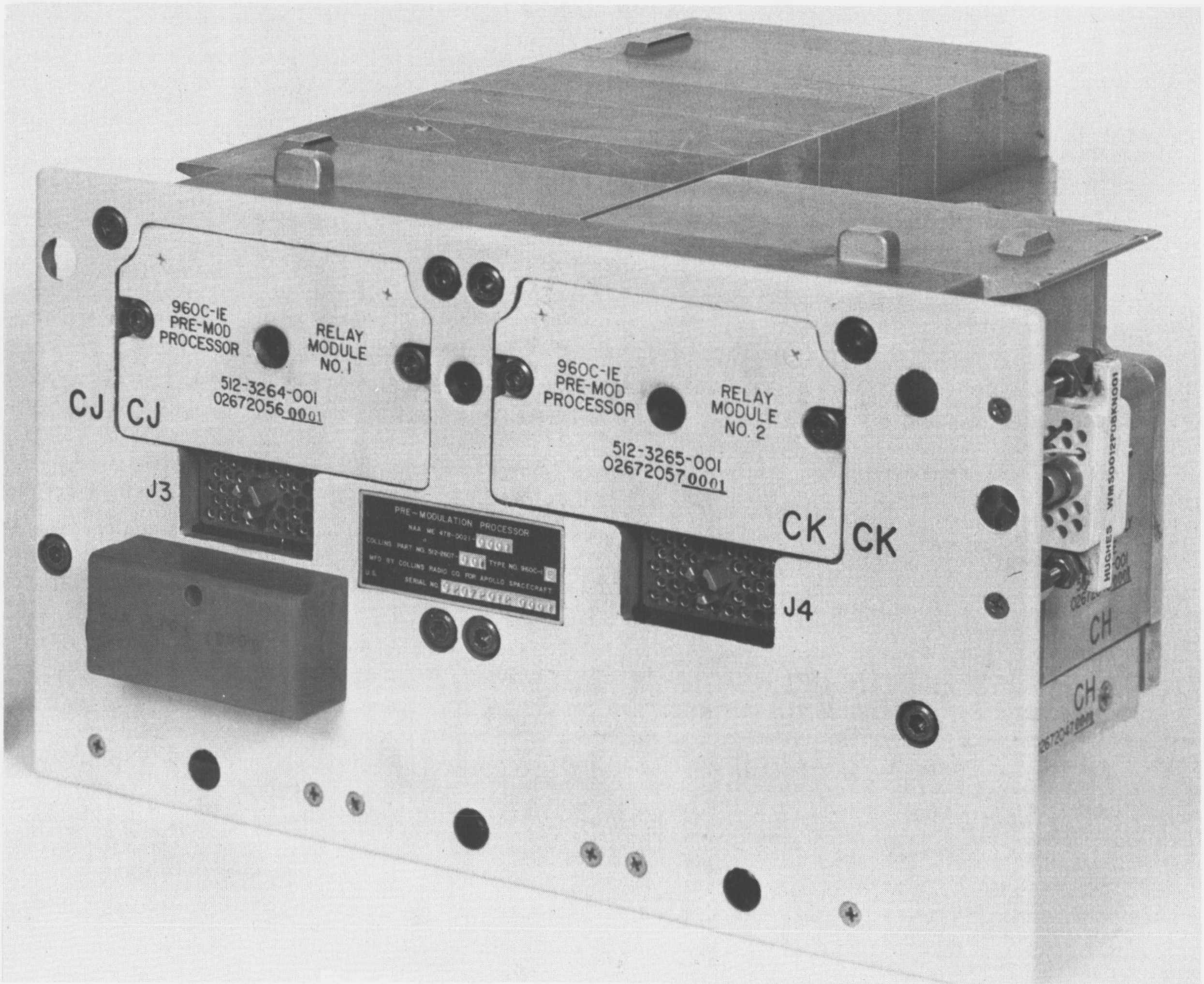

Figure 7. Premodulation Processor

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Three configurations were evaluated in a trade-off study of the steam duct heaters for the ECS as follows:

1. Two continuously operating heaters for the duct and duct outlet

2. Four continuously operating heaters (two for the duct and two for the outlet)

3. A system with two heaters continuously operating and two others on standby

The analysis showed that the standby system had the greatest inherent reliability.

An over-all analytical spacecraft model is being developed for manual calculation of crew safety and subsystem and spacecraft mission success reliabilities. This model will provide an accurate and economical means of quickly analyzing the effects of subsystem and mission changes on mission success and crew safety. The model can also be used to train reliability personnel in computing numerics and calculating over-all spacecraft reliability. Use of this model will permit the completion of an over-all spacecraft reliability analysis for a unique timeline in 5 to 10 days.

OPERATIONS

DOWNEY

Boilerplate 15

The stacking of the boilerplate 15 components in the Downey vertical assembly building was completed, the launch escape subsystem checkout was accomplished, and integrated systems testing was completed. The vehicle was then demated and prepared for shipment to the Florida facility.

On June 5, the service module, adapter, and some items of GSE were air-shipped to Cape Kennedy. The command module, launch escape tower, and other items of equipment were shipped on June 13.

Boilerplate 23

GSE for boilerplate 12 was shipped from WSMR to Downey where modifications were started to prepare it for use with Boilerplate 23. The modification of boilerplate 23 GSE will be completed, and the equipment will be verified for use during the next report period.

Preparations will continue for testing of the electrical power subsystem of boilerplate 14 (house spacecraft 1).

WHITE SANDS MISSILE RANGE

Mission Abort Operations

The boilerplate 12 post-flight power-on checkout and the data "quick-look" evaluation were completed. An evaluation of command module damage was conducted to differentiate damage caused by violent thrust termination from that of earth impact. The command module was then shipped to the Downey facility.

The boilerplate 12 launch escape subsystem sequencers and GSE were prepared and shipped to the Downey facility to be modified for use with boilerplate 23. The last of the GSE was shipped on June 4.

The modification of facilities and on-site GSE will continue during the next report period in preparation for boilerplate 23 field operations.

Propulsion Systems Development Facility (PSDF)

Installation of transducers on the F-2 test fixture engine was completed, and checkout was begun. The fuel portion of the test stand fluid distribution system was completed; leak and functional checkout of the engine was also completed during the report period.

The PSDF data acquisition system voltage control time-correlation testing was accomplished during the report period, as was the system voltage control oscillator harmonic distortion testing. Performance testing has been started.

The installation of the PSDF closed-circuit television system was completed on June 8.

The fuel and oxidizer ready storage units arrived at the PSDF and are undergoing receiving inspection.

The installation of the test stand fluid distribution system will be completed, and the engine will be installed in the test fixture during the next report period. The engine leak checks and functional checks will be completed, and the test fixture heat exchanger modification will be accomplished. The helium system hookup will be completed and verified. The test fixture instrumentation hookup, calibration, and checkout will be continued.

FLORIDA FACILITY

Boilerplate 13

The flight readiness review for boilerplate 13 was conducted on May 19. All boilerplate spacecraft systems were certified for flight.

The spacecraft-launch vehicle over-all test 3, verifying proper operation of the swing arm, was completed successfully on May 20.

The launch of boilerplate 13 by the Saturn I SA-6 launch vehicle was to be conducted at Cape Kennedy on May 26; it was rescheduled to May 28 because of launch vehicle problems during the countdown. All boilerplate 13 systems were "go" throughout the entire countdown.

Boilerplate 13 was launched successfully from the Eastern Test Range, Complex 37B, Cape Kennedy, at 12:08 p.m. EST on May 28 (see Figure 8). The test demonstrated the compatibility of the Apollo

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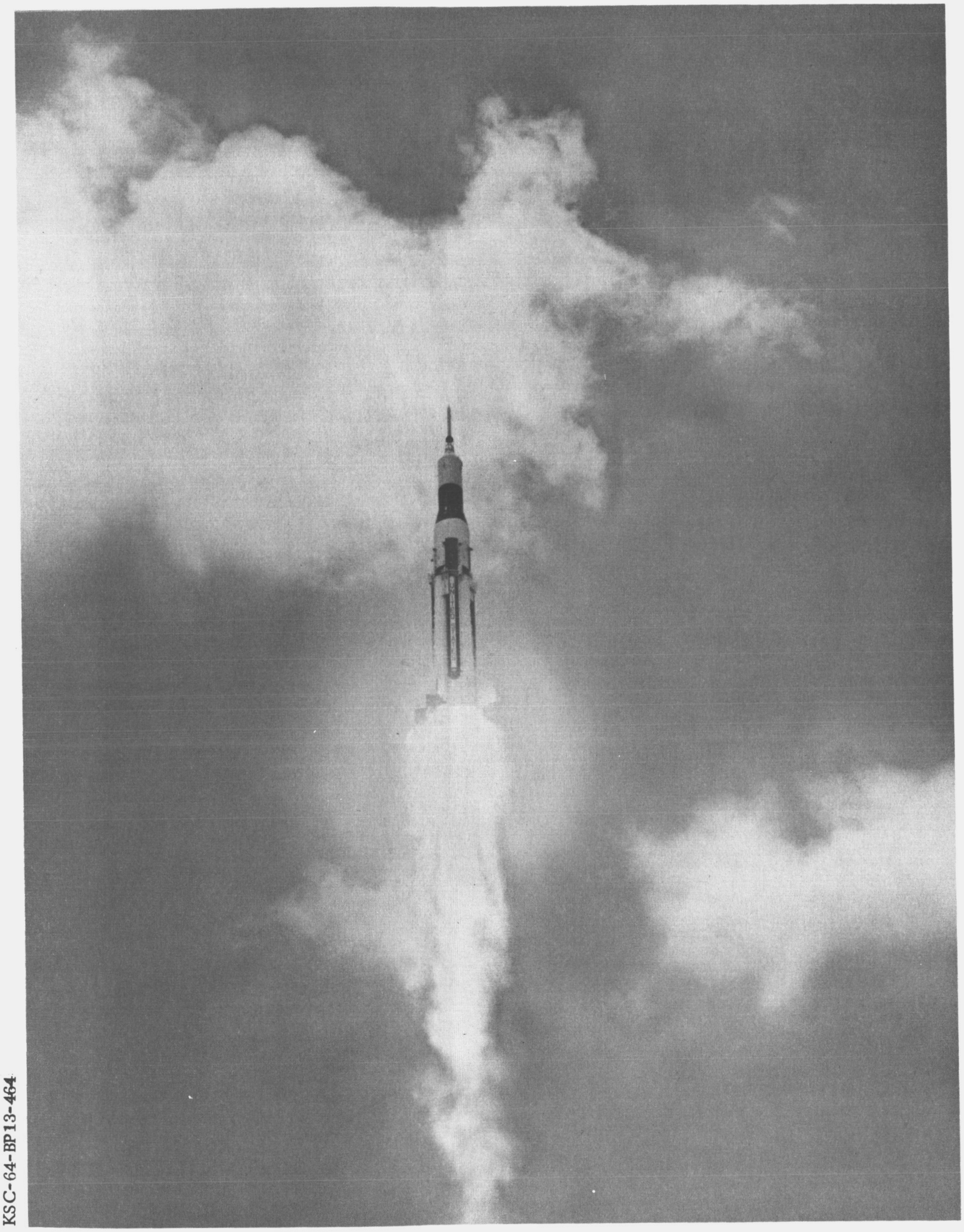

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Figure 8. Boilerplate 13 in Flight

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boilerplate spacecraft and the Saturn I launch vehicle under preflight and flight conditions. Examination of the data from the launch indicates that all objectives were accomplished.

Orbit insertion was completed at T + 629.5 seconds. The perigee and apogee altitudes were approximately 100 and 129 nautical miles, respectively. The orbit period was approximately 88.6 minutes. After 54 orbits were achieved, the vehicle entered the atmosphere east of Canton Island at 00302 (GMT) on June 1.

Boilerplate 15

Checkout operations for boilerplate 15 were started. The service module, adapter, and GSE arrived at Cape Kennedy on June 7 (see Figure 9). The adapter-S-IV instrumentation unit fit-check was completed on June 8. The commandmodule, launch escape system, and remaining GSE arrived on June 15.

7007-55-21R

Figure 9. Loading of Boilerplate 15 Service Module, Adapter, and GSE for Shipment to Cape Kennedy

The modified boilerplate 15 hangar AF operations are to be completed on June 24.

Mating of boilerplate 15 to the launch vehicle at complex 37B is scheduled for completion on June 26. All checkout of electrical systems will be accomplished at the pad. Field operations with boilerplate 16 are to start approximately August 15.

TEST PROGRAM SUPPORT

The final portion of the transposition phase of the docking study is being supported at the NAA-Columbus Division. This study includes an investigation of the piloting tasks under various simulated failure conditions, including reaction control subsystem engine quad failure and an unstabilized S-IVB condition. It was determined that the docking maneuver could be accomplished under these conditions.

Approximately one-third of the acceptance checkout spacecraft system equipment (station 1) has been installed and is undergoing unit checkout.

The lunar mission docking simulation is to continue into the next report period. The study will be continued to evaluate the various entry modes and their effect on propellant consumption, reaction control subsystem duty cycles, ranging capability and accuracy, over-all flight systems compatibility, and critical failure problem areas, and to perform pilot evaluation of the entry flight systems and modes.

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FACILITIES

DOWNEY

Systems Integration and Checkout Facility

Construction was completed on two of the three acceptance checkout equipment (ACE) stations, and General Electric is currently installing equipment.

The contract for construction of facilities to support the spacecraft instrumentation test equipment (SITE) was awarded.

Construction work in the telemetry station was completed.

Dip Brazing Facility

Revised drawings and specifications to extend the tube cleaning facility for salt bath brazing processing were completed and ready for bidding.

INDUSTRIAL ENGINEERING

Data Ground Station

The Apollo data reduction system package "B" was installed, and acceptance checkout was completed on June 12. Package "A" and "C" equipment will be transferred from the interim area to support test requirements.

Electrical Power Subsystem (EPS) Vacuum Chamber

The EPS vacuum chamber was installed in the space system development facility (SSDF). This will be used for fuel cell parallel operation testing and EPS qualification testing.

Space Systems Development Facility

The following areas were made operationally ready in SSDF since the last reporting period:

Data acquisition room
Structural area
Impact and vibration area (lower bay)
Gas dynamics area

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APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964

Subject	Location	Date	S&ID Representatives	Organization
Boilerplate 13 flight readiness review meeting	Cocoa Beach, Florida	May 16 to 30	Eslinger, Litsikas, Fisher, Harris, Otzinger, Beason, Ross	S&ID, NASA
Mission planning task force meeting	Houston, Texas	May 17 to 19	Myers, Meston	S&ID, NASA
Boilerplate 13 activities coordination	Cape Kennedy, Florida	May 17 to 21	Pyle	S&ID, NASA
Procurement specification negotiation	Rolling Meadows, Illinois	May 17 to 22	Schiavi, Cason, Yui, Hess	S&ID, Elgin
Checkout meeting	Cambridge, Massachusetts	May 17 to 22	Allen, Stahl, Hitz, Olds	S&ID, MIT
Real time simulation system evaluation presentation	Houston, Texas	May 18 to 19	Robertson, Barnett, Reeves	S&ID, NASA
Spacecraft 001 configuration discussion	Houston, Texas	May 18 to 19	Jusko	S&ID, NASA
Monthly coordination meeting	Lima, Ohio	May 18 to 20	Symons	S&ID, Westinghouse
Boilerplate 13 flight readiness review meeting	Cape Kennedy, Florida	May 18 to 20	Pearce	S&ID, NASA
Service propulsion subsystem test coordination	White Sands, New Mexico	May 18 to 20	Pastizzo	S&ID, NASA
Ultrasonic techniques investigation	Stratford, Connecticut	May 18 to 21	Murray, Rundell	S&ID, Krautkramer Ultrasonics
Spacecraft 001 presentation	Houston, Texas	May 18 to 21	Bergeron	S&ID, NASA
Project coordination meeting	Minneapolis, Minnesota	May 18 to 21	Bresenoff, Frankos	S&ID, Honeywell
Cost reduction meeting	East Hartford, Connecticut	May 18 to 22	Nash	S&ID, Pratt & Whitney
Spares review meeting	East Hartford, Connecticut	May 18 to 22	O'Reilly	S&ID, Pratt & Whitney
Design review meeting	Cedar Rapids, Iowa	May 18 to 22	McCandless, Murufas	S&ID, Collins
Technical progress evaluation	Sacramento, California	May 18 to 22	Borde, Mower, Carlson	S&ID, Aerojet
Development test program review	Minneapolis, Minnesota	May 18 to 23	Maxwell	S&ID, Honeywell

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Cost reduction meeting	East Hartford, Connecticut	May 18 to 24	Pohlen	S&ID, Pratt & Whitney
GSE project engineering support	White Sands, New Mexico	May 18 to Nov 16	Harris	S&ID, NASA
Technical and price problems resolution meeting	Phoenix, Arizona	May 19 to 20	Abrahamson, Gibb, Large	S&ID, Cannon
Rendezvous radar technical coordination meeting	Long Island, New York	May 19 to 20	Damm, Bologna	S&ID, Grumman
Spacecraft 008 intercom requirements coordination	Houston, Texas	May 19 to 21	Davis	S&ID, NASA
Cost reduction meeting	Lowell, Massachusetts	May 19 to 21	Morant	S&ID, Avco
Telemetry report review	White Sands, New Mexico	May 19 to 22	Rathjen	S&ID, NASA
Boilerplate 12 postflight review	White Sands, New Mexico	May 19 to 22	Howard	S&ID, NASA
Program management cost reduction and program review	Lowell, Massachusetts	May 19 to 22	Lowery, Myers, Paup, Shea, Church, Erb, Morant	S&ID, MIT
Breadboard tests	Washington, D.C.	May 19 to 22	Iwasaki, Solitario	S&ID, Melpar
Design and procurement problems review	Newark, New Jersey	May 21 to 24	Knox, Cheshire	S&ID, Weston Instruments
Technical coordination meeting	Princeton, New Jersey	May 19 to 26	Kolb	S&ID, RCA
Zero-gravity flight tests participation	Dayton, Ohio	May 19 to 28	Armstrong	S&ID, NASA, USAF
Technical meeting	Sandia Base, New Mexico	May 2 to 21	Necker	S&ID, Sandia
Pretest conference	Tullahoma, Tennessee	May 20 to 21	Emerson, Scottoline	S&ID, NASA
Communications and data subsystems status review meeting	Cedar Rapids, Iowa	May 20 to 22	Page, McCarthy, Dorrell, Milham, Renfroe, McCandless, Hightower, Rose	S&ID, Collins
Thermal engineering coordination meeting	Minneapolis, Minnesota	May 19 to 22	Reithmaier, Copeland	S&ID, Honeywell
Dynamic motion simulator servo system problem areas meeting	Shawnee, Oklahoma	May 20 to 23	Sorenson, Morse, Statezni	S&ID, Shawnee Industries

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Subcontractor program realignment discussions	Binghamton, New York	May 20 to 23	Marshall	S&ID, General Precision
Design problems discussion	Southampton, Pennsylvania	May 20 to 24	Himmelberg	S&ID, Vector
Operating procedures discussion	Boston, Massachusetts	May 20 to 24	Latino, Hershberger, Peacock, Yee	S&ID, MIT
Design review and management meeting	Cedar Rapids, Iowa	May 20 to 24	Hagelberg	S&ID, Collins
G&N operational procedures discussion	Cambridge, Massachusetts	May 20 to 24	Niemand	S&ID, MIT
Facilities technical review	Roseland, New Jersey	May 20 to 28	Butler, Errington	S&ID, Resistoflex
Service propulsion subsystem test coordination	White Sands, New Mexico	May 20 to 28	Sheffer, Morris	S&ID, NASA
Technical requirements negotiation	Phoenix, Arizona	May 21	Reed, Taggart	S&ID, Motorola
Subcontractor management program review	Minneapolis, Minnesota	May 21 to 22	Levine, Myers, Shea	S&ID, Honeywell
Contract implications discussion	Houston, Texas	May 21 to 22	Kennedy	S&ID, NASA
Apollo engineering data coordination	Houston, Texas	May 21 to 22	Harper	S&ID, NASA
Facilities inspection and evaluation	Cleveland, Ohio	May 21 to 22	Murphy, Copeland	S&ID, NASA
Mechanical systems meeting	Houston, Texas	May 21 to 22	Harris	S&ID, NASA
Propulsion subsystem maintenance concept discussion	Houston, Texas	May 21 to 22	Gallanes	S&ID, NASA
Collins management coordination meeting	Cedar Rapids, Iowa	May 21 to 23	Myers, Paup, Beeman, Hagelberg, Webster, Pope	S&ID, Collins
Communications equipment design review meeting	Cedar Rapids, Iowa	Mau 21 to 23	Webster	S&ID, Collins
GSE status review	Minneapolis, Minnesota	May 21 to 28	Gibson	S&ID, Honeywell
Fabrication and assembly status review	Binghamton, New York	May 24 to 29	Erickson	S&ID, Farrand Optical

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Monthly coordination meeting	Indianapolis, Indiana	May 24 to 31	Ellis, Rood, Dykstra, Perry	S&ID, Allison
Procurement specification technical coordination	Cincinnati, Ohio	May 25	Campbell, Handy	S&ID, Keco Industries
Engineering simulation review	Houston, Texas	May 25 to 26	Robertson, Chamberlain	S&ID, NASA
Contract negotiations	Houston, Texas	May 25 to 26	Drucker	S&ID, NASA
Spacecraft 009 mission planning meeting	Houston, Texas	May 25 to 26	Kellett, Shanahan, Fouts	S&ID, NASA
Fluid distribution system coordination	Las Cruces, New Mexico	May 25 to 27	Barricklow	S&ID, NASA
Administration and support requirements coordination	Houston, Texas	May 25 to 27	Henderson	S&ID, NASA
ICD subpanel meeting	Huntsville, Alabama	May 25 to 28	Chambers, Schnieder	S&ID, NASA
Boilerplate 13 launch attendance	Cape Kennedy, Florida	May 25 to 28	Osbon	S&ID, NASA
Monthly coordination meeting	Indianapolis, Indiana	May 25 to 30	Rood, Dykstra, Perry, Ellis	S&ID, Allison
Atmospheric controller briefing	Houston, Texas	May 26 to 27	Kroffe, Morris	S&ID, NASA
Engineering problems resolution	Paramus, New Jersey	May 26 to 28	Marine	S&ID, ACF Electronics
Interface requirements coordination meeting	Cape Kennedy, Florida	May 26 to 28	Isobe, Whitehead	S&ID, NASA
Project engineering coordination	Sacramento, California	May 26 to 28	Borde, Mower	S&ID, Aerojet
Soldering specifications discussions	Lima, Ohio	May 26 to 31	Champaign, Shelly	S&ID, Westinghouse
Fuel cell subcontractor review	Hartford, Connecticut	May 26 to June 4	McCarthy, Nelson	S&ID, Pratt & Whitney
Boilerplate 12 postflight review	Houston, Texas	May 26 to 27	Helms	S&ID, NASA
Digital computer evaluation	Houston, Texas	May 27 to 28	Barnett, Reeves	S&ID, NASA
G&N instrumentation meeting	Milwaukee, Wisconsin	May 27 to 29	Ferry	S&ID, AC Spark Plug

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Management coordination meeting	Long Island, New York	May 27 to 31	Treman, Damm, Anderson, Goldman	S&ID, Grumman
High-gain antenna program presentation	Houston, Texas	May 31 to June 1	Hagelberg, Matisoff	S&ID, NASA
Spacecraft 008 detailed test requirements meeting	Houston, Texas	May 31 to June 3	Foust, Altenbernd Murphy	S&ID, NASA
Electromagnetic interference design problems solution	Lima, Ohio	May 31 to June 5	Frankos	S&ID, Westinghouse
GSE engineering activities coordination	Houston, Texas	May 31 to June 10	Clauder	S&ID, NASA
Thermal vacuum test program project integration representation	Houston, Texas	May 31 to June 12	Howard	S&ID, NASA
Design review meeting	Cedar Rapids, Iowa	June 1 to June 3	McCandless	S&ID, Collins
Monthly coordination meeting	East Hartford, Connecticut	June 1 to 3	Pohlen	S&ID, Pratt & Whitney
Ordnance component data collection meeting	Houston, Texas	June 1 to 3	Hitchens	S&ID, NASA
Project engineering coordination meeting	Sacramento, California	June 1 to June 5	Mower	S&ID, Aerojet
Apollo static force test	Mountain View, California	June 1 to 26	Donovan	S&ID, NASA
Valve design and schedule review	Sacramento, California	June 2 to 3	Cadwell, Roznos	S&ID, Aerojet
Transmitter receiver design review	Cedar Rapids, Iowa	June 2 to 4	Murufas	S&ID, Collins
Acceptance test procedures and data sheets review	Cedar Rapids, Iowa	June 2 to 5	Griffiths	S&ID, Collins
Breadboard test program discussion	Houston, Texas	June 2 to 6	Hair	S&ID, NASA
Integrated guidance and control conference	Houston, Texas	June 3 to 4	Levine, Knobbe	S&ID, NASA
Test requirements discussion	White Sands, New Mexico	June 3 to 5	Gallanes	S&ID, NASA
Mechanical design review meeting	Cedar Rapids, Iowa	June 3 to 5	Whitehead, Zahn	S&ID, Collins

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Stabilization and control engineering support meeting	Minneapolis, Minnesota	June 4 to 12	Ferentz	S&ID, Honeywell
Simulation facilities observation	Moffet Field, California	June 5	McPhail, Fitzgerald	S&ID, Ames Research Center
Monthly coordination meeting	Binghamton, New York	June 5 to 9	Wright	S&ID, Link
Altitude tests and motor tie down	Houston, Texas	June 7 to 8	Babcock	S&ID, NASA
Low-pressure chamber indoctrination	Lancaster, California	June 7 to 9	Osborne, Nelso, Jolly	S&ID, Edwards AFB
Command system subpanel investigation	Houston, Texas	June 7 to 11	Covington	S&ID, NASA
Abort vehicle program coordination	Houston, Texas	June 7 to 11	Greene, Kraly, Dacus	S&ID, NASA
Cost proposals field analysis	Lowell, Massachusetts	June 7 to 12	Lowery, Wagner, Spritzler, Pertile, Statham, King	S&ID, Avco
Mission simulator monthly coordination meeting	Binghamton, New York	June 7 to 12	Hatchell	S&ID, General Precision
SPS propellant utilization and gaging system coordination	Burlington, Vermont	June 7 to 15	McKellar, Bankson	S&ID, Simmonds Precision Products
Launch escape tower umbilical engineering review	Phoenix, Arizona	June 8	Abrahamson, Large, Gibb	S&ID, Cannon
Single point flotation studies status review	Houston, Texas	June 8 to 9	Underwood	S&ID, NASA
Boilerplate 23 test point conference	Houston, Texas	June 8 to 9	Helms, Christian	S&ID, NASA
Acceptability of gimbal actuators evaluation	Sacramento, California	June 8 to 9	Fow	S&ID, Aerojet
Monthly coordination meeting	Chicago, Illinois	June 8 to 12	Villafan	S&ID, ITT
C-band transponder acceptance test participation	Paramus, New Jersey	June 8 to 11	Kronsberg, Porche	S&ID, ACF Electronics
Technical progress and implementation of design changes coordination	Sacramento, California	June 8 to 12	Mower	S&ID, Aerojet
Qualification test procedures discussion	Dayton, Ohio	June 8 to 12	Scott, Mann	S&ID, Globe Industries

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Conduct heat transfer tests	Tullahoma, Tennessee	June 8 to 19	Emerson	S&ID, NASA
Engine assembly design review	Sacramento, California	June 9 to 10	Field	S&ID, Aerojet
Humidity, packaging aspects, and qualification test program meeting	Houston, Texas	June 9 to 10	McCarthy, Levine, Troolines, Van Meter	S&ID, NASA
Clear Lake site activation coordination	Houston, Texas	June 9 to 11	Mulligan	S&ID, NASA
Manual thrust vector control simulation review	Minneapolis, Minnesota	June 9 to 11	Oglevie	S&ID, Honeywell
Functional requirements discussion	Bethpage, Long Island, New York	June 9 to 11	Ross	S&ID, Grumman
Breadboard test program and schedules discussion	Houston, Texas	June 9 to 12	Sheere, Hair	S&ID, NASA
AMS mission effects projector design review	New York, New York	June 9 to 12	LaFrance, Brown	S&ID, Farrand Optical
Procurement specification negotiation	Hartford, Connecticut	June 9 to 12	Alpert	S&ID, Pratt & Whitney
Test data working group meeting	Cambridge, Massachusetts	June 9 to 13	Phillips, Egan	S&ID, MIT
Boilerplate 15 field activities direction	Cocoa Beach, Florida	June 9 to 30	Condit	S&ID, NASA
Test results review	Minneapolis, Minnesota	June 9 to 26	Gibson	S&ID, Honeywell
Phase II cleanliness and quality control requirements review	Tullahoma, Tennessee	June 10 to 11	Cadwell	S&ID, NASA
Equipment test participation	Cedar Rapids, Iowa	June 10 to 11	Hall	S&ID, Collins
Nuclear radiation area future activities discussion	Houston, Texas	June 10 to 11	Laubach, Raymes	S&ID, NASA
S-band system tests discussion	Scottsdale, Arizona	June 10 to 11	Hall	S&ID, Motorola
Specification requirements discussion	Houston, Texas	June 10 to 11	Harrington, Perkins	S&ID, NASA
SCS technical briefing	Minneapolis, Minnesota	June 10 to 11	Kelley	S&ID, Honeywell

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Cost reduction meeting	Houston, Texas	June 10 to 11	Mazur	S&ID, NASA
Electronic interface problems meeting	Framingham, Massachusetts	June 10 to 12	McCulloch, Wheeldon, Wright	S&ID, Computer Control
Design problems resolution	Princeton, New Jersey	June 10 to 12	Green, Marzek, Engert	S&ID, RCA
Specification and engineering change procedure requirements review	Houston, Texas	June 10 to 12	Harrington	S&ID, NASA
Flush-mounted antennas technical conference	College Park, Maryland	June 10 to 13	Bensimon	S&ID, Emertron
Delivery schedule improvement meeting	Minneapolis, Minnesota	June 10 to 17	Valkenburg	S&ID, Honeywell
Design review and coordination meeting	Cedar Rapids, Iowa	June 10 to 21	Himmelberg, Barrier	S&ID, Collins
Apollo mission simulators	Binghamton, New York	June 10 to 25	Smith	S&ID, General Precision
Proposal negotiations	Houston, Texas	June 11	Perkins, Badger	S&ID, NASA
Test results observation	Goleta, California	June 11	Jones, Richardson	S&ID, General Motors
Communication system acceptance tests participation	Cedar Rapids, Iowa	June 11 to 12	Lee	S&ID, Collins
Site activation group coordination	White Sands, New Mexico	June 11 to 12	Cardona	S&ID, NASA
Testing of SPS tanks technical meeting	Indianapolis, Indiana	June 10 to 13	Krainess	S&ID, Allison
Control panel and hand control study report	Houston, Texas	June 10 to 29	Bresenoff, Campbell	S&ID, NASA
Proposal negotiations	Houston, Texas	June 11 to 13	Drucker, Hamilton	S&ID, NASA
Boilerplate 15 checkout test preparation	Cocoa Beach, Florida	June 13 to 24	Pearce	S&ID, NASA
Electronic subcommutator design review	Southampton, Pennsylvania	June 14 to 15	Anderson, Brown	S&ID, Vector
Technical assistance negotiation	Binghamton, New York	June 14 to 16	Finley	S&ID, Link

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S&ID Schedule of Apollo Meetings and Trips
May 16 to June 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
ICD subpanel meeting	Houston, Texas	June 14 to 16	Chambers	S&ID, NASA
Cryogenic storage system evaluation	Boulder, Colorado	June 14 to 17	Pohlen	S&ID, Beech
Acceptance test procedure	Scottsdale, Arizona	June 15 to 19	Bickerstaff, Marfice	S&ID, Motorola

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